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Before the
Federal Communications Commission
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of

Inquiry Concerning Deployment of	)	
Advanced Telecommunications	)	
Capability to All Americans in a Reasonable	)	CC Docket No. 98-146
and Timely Fashion, and Possible Steps	)	
to Accelerate Such Deployment Pursuant	)	
to Section 706 of the Telecommunications	)	
Act of 1996	)	

NOTICE ON INQUIRY

COMMENTS OF *iAdvance*

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March 20, 2000

iAdvance is pleased to submit the following initial comments in the above referenced proceeding. In this proceeding the Commission asks if it should act to encourage deployment of advanced telecommunications services to all Americas. iAdvance's response is a resounding YES. It has been more than four years since Congress reaffirmed the Commission's authority to act in Section 706 of the 1996 Telecommunications Act.

I. Introduction

iAdvance is a Washington-based coalition of public interest groups, telecommunications, computer, Internet and technology companies, which support affordable access to the high-speed Internet for all Americans.

Members of iAdvance include Alliance for Public Technology, American Council on Education, American Telemedicine Association, Bell Atlantic, BizNews24.com, Dialogue on Diversity, Gateway, Helfrich Company, Juno, National Association of Development Organizations, National Association of Commissions for Women, National Black Chamber of Commerce, NetNoir, SBC, Sunrise Telecom, TodoLatino.com., U.S. Internet Industry Association.

Attached hereto are two reports released by iAdvance – *Breaking the Backbone* and *A 21st Century Internet of All Americans.* Together these reports detail how antiquated laws and regulations are slowing deployment of advanced telecommunications services to all Americans.

Breaking the Backbone is a detailed statistical analysis of the deployment of high-speed, high-capacity backbone hubs or points of presence in the United States. These are the on and off ramps of the information superhighway. How close you are to one of these connections will affect the price, quality and speed of your Internet service. The study concludes that there would be twice as many of these hubs if the regional Bell operating companies were allowed to transmit date over antiquated LATA boundaries.

A 21st Century Internet for All Americans concludes that we are witnessing the creation of a broadband digital divide in this country, a divide that separates urban "haves" from rural "have nots".

This disturbing conclusion was reinforced last week at a two-day meeting of the U.S. Congressional Rural Caucus. Members of Congress and advocates for rural America came together to address the lack of advanced telecommunications services in the heartland and the hollows of rural America. The conclusion of the proceedings was that rural America needs help.

II. "Not much has changed"

About one year ago, *Time* Magazine wrote about Wiley Middleton. Middleton is, according to *Time*, "a 45-year-old graphics designer who honed his craft in bigger cities." Middleton moved back to his native Leadville, Colorado, eager to trade urban pressures for the serenity of this historic mining town of 3,421. But Leadville's telephone system [was] quaint too, and [would not] let his computer modem send the digital images that are his livelihood. This regularly force[d] Middleton to drive two hours to Denver to deliver electronic designs for brochures and ads, 'I can't compete,' he lament[ed], again facing the prospect of leaving Leadville for the city. 'The phone line is too small.' Or too narrow to be more precise."[1]

[1] Chris O'Malley, "The Digital Divide: Small Towns the lack high-speed Internet access find it harder to attract new jobs," Time Magazine, March 22, 1999.

According to *Time* "the aging patchwork of thin wires and microwave towers that brings phone service to millions of Americans in remote spots like mountainous Leadville can barely transmit at speeds of 28.8 kilobits per second or less--assuming they can dial up a local Internet service at all. Meanwhile, much of the country has moved up to 56K modems or adopted one of the new broadband telephone and cable-company services that bring the net to homes and businesses up to 100 times as fast."[2]

We called Mr. Middleton last week at his office in Leadville. He was not there. He was at his office in Denver! When we did contact him via e-mail he told us that "not much has changed."

At about the same time that Mr. Middleton's story appeared in *Time* Magazine, the Commission concluded that the deployment of advanced services was proceeding at an acceptable pace and that there was no need for the Commission to exercise its authority to speed things up.

While the regional Bell companies serve over two-thirds of rural America, other initiatives may be needed to meet the needs of communities like Leadville. At the U.S. Congressional Rural Caucus event, several strategies were discussed, including rural cooperatives, loan guarantee programs, and wireless and satellite networks. But allowing the regional Bell companies to invest and compete in the interLATA data market will help close the rural/urban broadband digital divide.

III. Leadville is not alone

We have been saying it since iAdvance hit the scene eight months ago: the demand for new information age services like telemedicine, e-commerce, distance

[2] Ibid.

learning, and telecommuting will require significant new investments in bandwidth not just in Ledville but across America.

Just a year ago, experts were predicting a bandwidth glut. Now they are predicting a possible bandwidth shortage.[3]

According to a recent article in *Inter@active Week Online*, "that giant sucking sound you hear is the collective gasps of enterprises and service providers that were expecting the massive build-out of the public network to produce bandwidth in quantities as plentiful as the air they breath."[4] "'In the next five years we don't see any ability of service providers in the U.S. to keep up with the demand,' said Mouli Ramani, director or strategic marketing for the optical Internet at Nortel Networks. 'I don't see any chance of getting into a glut anywhere in the network over the next five years.'"[5]

And the *Wall Street Journal* reports that "The cable industry's rush to wire up America with high-speed Internet access is running into a serious problem: Too many heavy Internet users are crowding online at once, in some cases creating major bottlenecks and slowdowns."[6]

The cable modem industry is in its infancy, with just over one million subscribers. The bottlenecks described in the *Wall Street Journal* article result from problems with the technology, including shared pipes and slow upstream speeds.

These developments, too, stand in stark contrast to the Commission's findings of just one year ago.

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[3] See Joe McGarvey, "Deflating Bandwidth Glut Predictions," Inter@active Week Online, February 24, 2000.
[4] Ibid.
[5] Ibid.
[6] Leslie Cauley, "Heavy Traffic is Overloading Cable Companies' New Internet Lines," Wall Street Journal, March 16, 2000, pages B1, B16.

IV. The Commission should act to encourage new investment in advanced telecommunications capability

The two studies released earlier by iAdvance, *Breaking the Backbone* and *A 21st Century Internet for All Americans,* detail how lifting the long distance data restriction will encourage investment in bandwidth and in communities that are at risk of being on the wrong side of the broadband digital divide.

Local telephone companies are uniquely positioned to serve rural and inner city America, small business, small cities and towns, and suburban communities. These are their markets; the people and communities they already serve. It is time to let them bring the promise of 21st Century technology to all Americans.

Let's not wait until we face a bandwidth crisis. The Commission has the opportunity to act today; to do something positive that will make a difference in communities throughout America.

iAdvance urges the Commission to use its authority under Section 706 of the Telecommunications Act of 1996 and Section 10 of the Communications Act of 1934, as amended, to enhance the deployment of advanced telecommunications services by lifting the interLATA restriction on the regional Bell operating companies for the provision of data services and removing other barriers to investment and competition.

Respectfully submitted,

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March 20, 2000

Breaking the Backbone:

The Impact of Regulation on Internet Infrastructure Deployment

July 27, 1999

Erik R. Olbeter

Matt Robison

Executive Summary

This study attempts to determine the economic and regulatory incentives for Internet backbone hub deployment and whether changes in government policies can effect that deployment. Using statistical models, the paper decisively concludes that interLATA data regulations have slowed the growth and diffusion of the high-speed Internet backbone, specifically Internet backbone hubs. Over 60 percent of metropolitan areas do not have access to these hubs, and in rural areas they are virtually non-existent. If there were no interLATA data regulations, we would expect there to be twice as many backbone hubs in the country today.

Furthermore, this paper identifies twelve states – the "Disconnected Dozen" – that are falling behind in deployment of Internet backbone hubs and are now at serious risk of being denied the end-to-end broadband Internet access their citizens require to stay competitive in the emerging digital economy. While the regulation of data transmission is delaying the deployment of backbone hubs to virtually all areas of the country, these twelve states have been especially hard-hit and can be expected to suffer significant economic consequences if current regulations are left unchanged.

It is helpful to think of Internet backbone hubs as train stations, and the Internet backbone as the rail network connecting cities. Internet service providers and businesses must connect to these hubs in order to participate in ecommerce, ebusiness, and the Internet in general.

Just as there were tremendous advantages to settling towns around train depots in the 1800s, proximity to an Internet backbone hub is crucial to economic vitality. One hundred years ago, residents in towns that were not served by train stations had to use horses and buggies across dirt roads to get to the train stations. This slow, inefficient, and arduous transit made these towns less competitive than towns served by train stations. The same is true today. The greater the distance from a town to an Internet hub, the more expensive the service, constrained the speed of the service, and limited the service offerings. These towns can get on the slower, narrowband Internet, but cannot acquire broadband connectivity at a reasonable price, if at all.

The broadband Internet is fast becoming an essential infrastructure for business. Broadband ecommerce applications are providing enormous choice, value, and benefit to users, and ebusiness is quickly becoming an essential tool for the manufacturing, service, and agricultural sectors. Communities not served by Internet backbone hubs risk losing critical industries to connected cities, and their citizens risk missing out on the full educational and commercial benefits of the Internet.

For example, broadband connectivity could help U.S. businesses reduce inventories by $1 trillion – saving more than $120 billion per year. This saving would free up $120 billion per year for new investment, worker training, and economic expansion. IBM estimates that electronic billing systems would save banks, billers, and customers as much as $46 billion per year, and current large users of broadband networks are already reporting unprecedented savings and competitive advantages. In all, according to a study by the Economic Strategy Institute, a dramatic shift to broadband networks could add $616 to $721 billion to the U.S. GDP and 4.4 to 5.5 million new jobs by 2005.

The backbone hubs necessary for providing such benefits, however, are to a large extent available only in the country's largest metropolitan areas. Smaller cities and non-metropolitan areas do not have the same access to these high-speed connection points. In fact, 60.7 percent of all metropolitan areas do not have a connection to a backbone hub, and while over one thousand hubs have been put in place, less than one hundred are in non-metropolitan areas – and most of these are in university towns. The vast majority of Americans do not have direct access to the Internet backbone in their own communities.

Network economics and the nature of telecom markets give strong incentives to deploy networks in densely populated and high-income areas. In addition, regulations affecting investment, markets, and suppliers also impact backbone deployment. The model used in this study attempts to determine the role that regulations – such as the prohibition against Regional Holding Companies (RHCs) offering data across inter-LATA (or local) boundaries – play in exacerbating or ameliorating this disparity in overall number of backbone hubs per state.

Using standard regression analysis, this study shows that two economic factors have a statistically significant and positive impact on the number of backbone hubs constructed in a state: per-capita income per state; and the number of cities with populations over 100,000. This is not surprising. Backbone network builders are targeting customers in densely populated areas with dollars to spend. This strategy allows network providers to spread their costs over a large number of people who have the income to buy numerous services.

This study also finds that another variable is a statistically significant determinant of backbone hub deployment: regulation. When independent local exchange companies – those not under backbone deployment prohibitions – own a significant number of access lines in a state, more backbone hubs are built. In essence, when local exchange companies and their Internet service provider affiliates have the freedom to build Internet backbone hubs and networks, they build them. The variable used only accounts for incumbent providers – not competitive local exchange carriers. What this suggests is that the presence of this regulation has slowed down the construction of this key part of the Internet. It also suggests that removing interLATA restrictions on the RHCs – those ILECs which are under broadband deployment prohibitions – will have a significant and measurable impact on the diffusion of Internet backbone hubs. Moreover, the incentive to build does not solely apply to rich or densely populated locations – it applies to every state, regardless of circumstances.

The model also tested the theory that competition for local telephony subscribers drives Internet backbone hub deployment. Surprisingly, it is impossible to conclude that local voice competition has any relationship to the building of Internet backbone hubs.

The study identifies a "Disconnected Dozen" – twelve states that have significantly fewer hubs than most other states on a per-capita basis and are at serious risk of falling behind in the digital economy. Without an increase in hub deployment, these high-risk states stand to suffer significant economic consequences.

Furthermore, our model shows that regulations have seriously impeded the deployment of hubs in these states. If there were no regulations on the transfer of data, we would expect that each of these states would have substantially more backbone hubs today (see chart).

The Disconnected Dozen

States at Highest Risk

State	Actual number of hubs	Expected number of hubs if all lines were unregulated
Alabama	6	40
Arkansas	2	28
Idaho	2	30
Iowa	3	33
Maine	0	29
Montana	0	26
New Hampshire	3	42
North Dakota	0	24
Oklahoma	7	33
South Dakota	0	30
West Virginia	0	24
Wyoming	1	30

While states in the "Disconnected Dozen" have been most noticeably affected by regulatory barriers, the study clearly demonstrates that regulations are slowing the Internet for *all* consumers and are preventing millions of Americans from accessing the benefits of the digital economy. The study shows that if there were no restrictions on the transfer of data, we could expect twice as many backbone hubs in the country today. Lifting the restriction on transfer of data across interLATA boundaries would promote investment and increase the deployment of backbone hubs, not just in the "Disconnected Dozen," but in all regions of the country. Nearly every state, including those that are doing comparatively well at present, would benefit from this broadband windfall. Without such action, millions of Americans face the very real possibility of standing on the side of the road as the information railway passes them by.

Background

Backbone hubs are the gateways where Internet Service Providers (ISPs), corporations, and local telephone carriers connect to the Internet backbone, which carries Internet traffic around the world. It is helpful to think of Internet backbone hubs as a train stop on a national railroad network. In the railroad system, there are only so many places to get on a train – the stations. Backbone hubs serve as today's Internet train stations, allowing people to climb aboard and participate in ecommerce and ebusiness and partake in the Internet revolution. Just like in the old West, there are many states and towns where the Internet backbone rolls on by, but doesn't stop. Without an Internet backbone hub, there is no way to get on board the broadband Internet.

Having a nearby Internet hub serving a community provides a tremendous economic and social advantage. To further utilize the train analogy, one hundred years ago a town far away from a railroad stop was at a significant disadvantage as compared to a town right at the stop. The further town needed to construct expensive roads to get to the train depot, and often had more difficulty getting wares to market. Much the same can be said about today's Internet backbone hubs and their impact on communities. Communities that remain underserved will not be able to offer their business or household customers the broadband services available to the rest of the country at a comparable price – if at all.

When Internet backbone hubs are nearby, ISPs can directly connect to the facilities that carry the traffic around the country and around the world. These ISPs can offer their communities higher quality broadband service, lower costs, and, eventually, greater access to more broadband applications and services than communities far away from backbone hubs. Companies in rural areas without nearby Internet hub access will spend a significant amount more money to conduct crucial business functions, such as supply chain management, inventory control, and the like. ISPs with direct local access to backbone hubs can also guarantee higher broadband speeds, allowing residential users to take greater advantage of ecommerce, education, and telemedicine applications.

Building an Internet hub is not cheap. The necessary facility space, technical staff, back-up power supplies, industrial A/C, and routing equipment can cost up to $200,000. The equipment costs for backbone circuits are roughly the same for serving a big city as a small city. Local loop circuits vary substantially between rural and urban locations. An urban ISP providing broadband services to its customers will typically spend between $3,000 and $5,000 per month on necessary local loop circuits to connect to an Internet hub. In most cases, a rural ISP which desires to supply the same level of broadband service cannot buy the same connections, but those who can are typically forced to cross a LATA boundary.[1] These rural ISPs spend between $41,000 and $45,000 per month.[2]

Not only are costs higher in rural areas, but revenues are lower. While rural businesses such as agriculture have been among the most technology-savvy in the past, their sheer distance from one another means that

[1] An ISP in southeast West Virginia, for example, cannot purchase a DS3 from any of the interexchange carriers. Not buying this high-capacity circuit means that the ISP can not offer the same fast, reliable service as their counterparts in urban areas. Moreover, the new carriers laying fiber across America are building this capacity between the same cities as current providers – meaning that new providers such as Qwest and Level 3 will not assist rural ISPs and communities who wish to offer and use broadband services.

[2] Source: MCI/Worldcom wholesale rates. Rural ISPs need to buy an originating and terminating local loop circuit ($3,000–5,000 each) and an IXC circuit to cross the LATA boundary. In order to provide guaranteed broadband service to customers, an ISP must purchase a DS3 circuits. The IXC wholesale ISP rate for DS3 circuits can range anywhere from $25,000 to $45,000 per month. For this calculation, MCI/Worldcom's rate for a Hagerstown to Washington DS3 circuit ($35,000 per month) is employed.

a single hub can only garner revenue from a more limited pool of consumers. With these types of financial considerations and the lack of availability of high-speed lines, it is no wonder that rural broadband deployment is slower than urban buildout.

Charts 1 and 2 on the following pages depict the Internet topography and the role of Internet backbone hubs. The first chart shows and describes the efficiencies gained from being served by multiple Internet backbone hubs. It is important to note that being served by a single backbone hub is undesirable for businesses and may make Internet access more costly. Ideally for ecommerce and ebusiness, multiple backbone hubs would serve a community.

Chart 2 depicts the problems faced by rural ISP and their customers. In underserved areas, ISPs often reach the Internet backbone by "daisy chaining" (leased line A) to another ISP which has a leased line to an Internet hub. In many cases, these daisy chains stretch hundreds of miles. This process is much more expensive than having a direct connection to a local hub. The cost is added into a rural ISP's cost of doing business, and the risk of outage or delays increases because the ISP has just one, often lengthy path to an Internet hub. Towns and states not served by nearby backbone connections are required to spend significantly higher fees to get connected to the distant hub.

These expenses raise the cost of doing ebusiness, setting up a Web site, or starting an Internet start-up in remote areas. This is why Web companies and information providers such as Excite, AOL, eBay, Amazon.com, priceline.com, and VerticalNet avoid rural and underserved areas; they can get better prices and connections from ISPs close to Internet hubs.

As of spring 1999, there are 1,042 Internet backbone hubs across America.[3] However, these hubs are heavily concentrated in the largest metropolitan areas. 210 of the country's 346 metropolitan statistical areas (60.7 percent) do not have direct on-ramps to the Internet. Moreover, only 98 backbone hubs serve towns in non-metropolitan areas, and almost all of these serve universities. The chart below shows how extreme the digital divide is between cities across the United States.

City	Number of Hubs
Chicago	37
New York	37
Los Angeles	35
Washington	33
Atlanta	32
Cincinnati	6
Louisville	5
Omaha	3
Boise	2
Mobile	2
Greenville, SC	1
Little Rock	1
Bangor	0

[3] This represents the total number of backbone hubs for the 50 states and the District of Columbia. There are 984 hubs in the 46 states studied in this paper.

In the continental United States, nine states have only one or no backbone hubs. By comparison, California has 177 – more than the bottom 31 states combined. Chart 3, in the appendix, shows the number of backbones per state for all states, and the chart below compares the top and bottom ten.

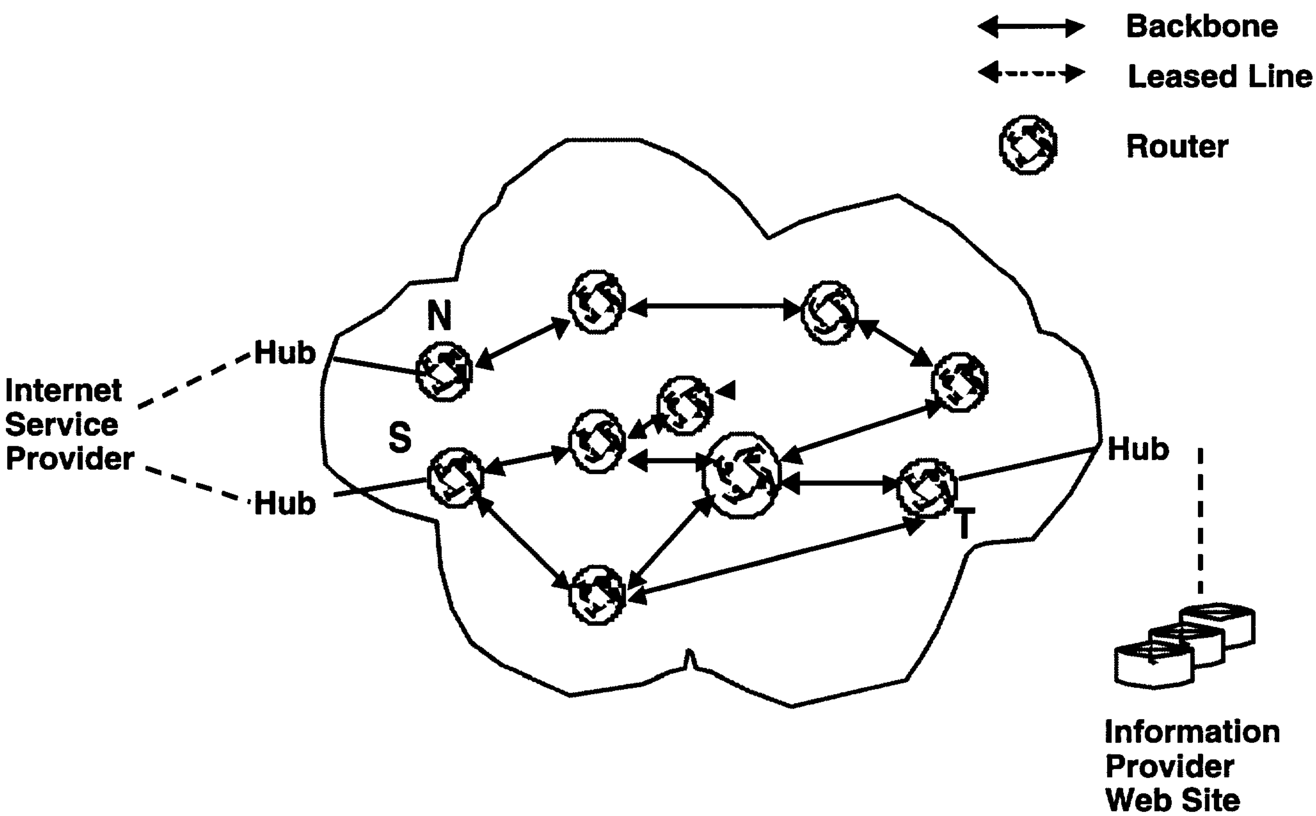
Top Ten States	No. Backbone Hubs
California	177
Texas	90
New York	58
Florida	58
Ohio	56
Illinois	44
Virginia	39
Missouri	38
Georgia	36
District of Columbia	34

There are more backbones in these states than in the rest of the country combined plus U.S. territories.

Bottom Ten States	No. Backbone Hubs
Delaware	2
Arkansas	1
Wyoming	1
Kansas	1
West Virginia	0
Montana	0
South Dakota	0
North Dakota	0
Maine	0
Vermont	0

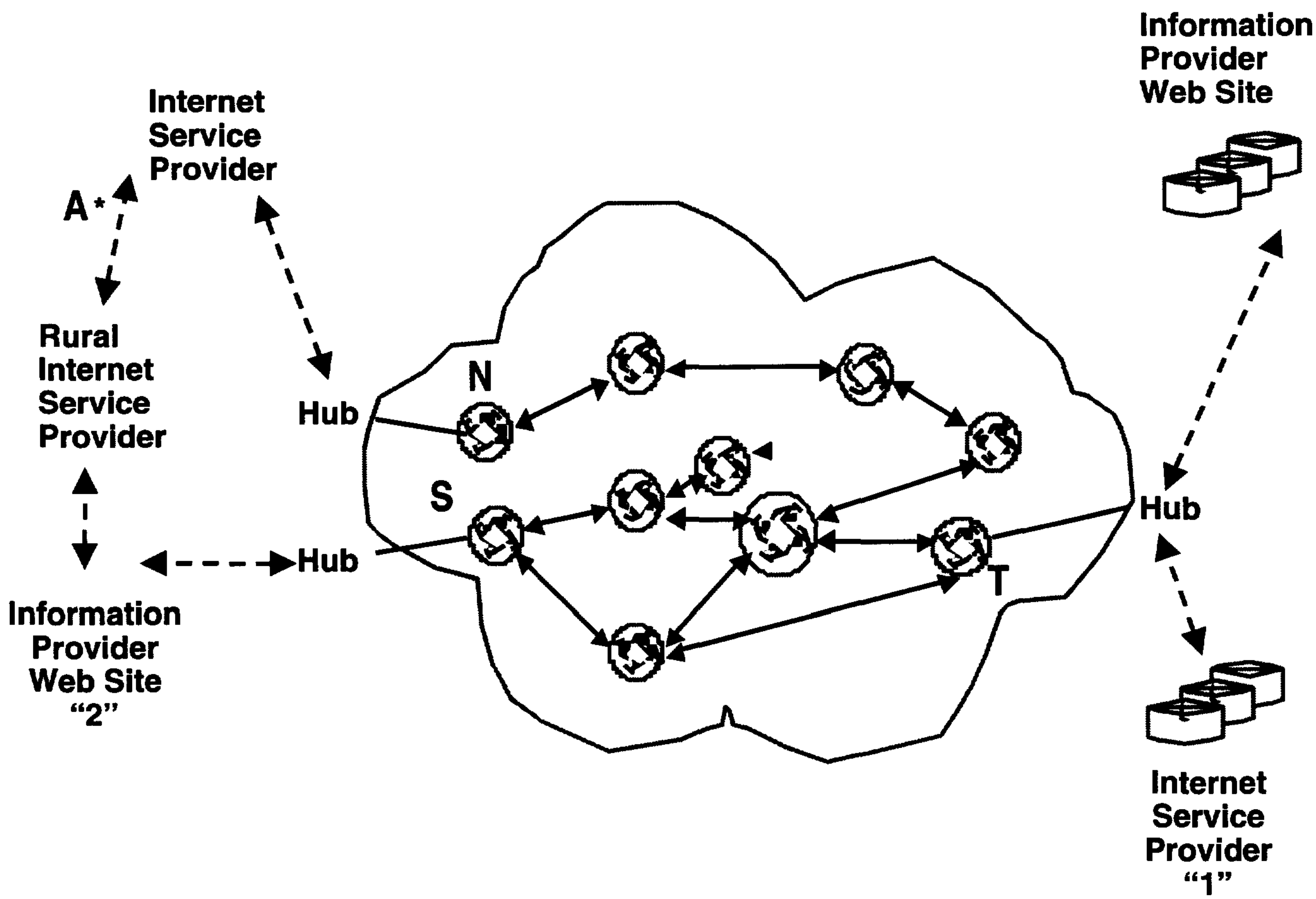
Given the importance of Internet hubs to economic and social development, it is important to understand the forces driving backbone hubs – what economic and regulatory factors influence a company to deploy a hub on the Internet railroad? The statistical model presented in this paper attempts to identify and to quantify these variables.

Connecting to the Internet: The Importance of Multiple Hubs



For an ISP, the route starting with **S** is the safer one because at each router heading toward the destination **T** there are at least two paths that can move packets forward. The ISP also has two choices – the hub for the router at **N** or the hub for router **S**. That means the ISP can continue operating when either **N** or **S** is having trouble. In contrast, the information provider has just one leased line to one hub. If that leased line or that router has trouble, the information provider is "out of business," while the trouble persists. For commercial information providers, multiple connections to the Internet is almost essential.

Connecting to the Internet: The Dual Problem for Rural Communities



*In rural areas, the choice of ISPs with better than a T1 leased-line connection to the Internet is often limited or non-existent. Remember – their connection must be big enough to serve all their online customers simultaneously. See Boardwatch's database of ISPs.

Hypotheses

As in all telecommunications markets, both market forces and regulations interact to influence investment decisions.[4] The backbone transport market is like any other network-based market. The high sunk cost, low marginal cost nature of the business means that companies will build first in densely populated, high-income areas. The more traffic that a community can generate, the greater the revenue base over which to spread sunk costs. This induces buildout in metropolitan areas. Companies look for areas with high per-capita income, as high-income areas typically have more Internet usage and the computer savvy that generates extra traffic as well as additional revenue streams. These two economic factors should prove key to explaining backbone hub deployment.

But another factor must be considered: regulation. This model tests the proposition that regulations imposed on RHCs not only dissuade investment in backbone hubs, but actually result in a lower number of backbone hubs in a state. Under the Telecommunications Act of 1996, the RHCs are forbidden from building Internet backbones or backbone hubs for any purpose – voice or data. No other local exchange carriers are under these interLATA restrictions. RHC local exchanges are also under strict price cap, resale, and unbundling guidelines spelled out in Sections 251-254 of the Act. Competitive LECs and Packet LECs are under no such restrictions. Neither are small, rural independent LECs.

A description of the types of local exchange companies and the applicable regulations are listed below.

Type of LEC	**Applicable Regulation**		
	interLATA Prohibition?	Price Cap?	Local Resale and Unbundling Requirements?
Competitive (CLEC)	No	No	No
Packet (PLEC)	No	No	No
RHCs	*Yes*	*Yes*	*Yes*
Large Independent (large – ILEC)	No	*Yes*	*Yes*
Small Independent (small – ILEC)	No	*Yes*	No[5]

Why would interLATA rules impact Internet hub deployment? RHCs are the only carriers not permitted to build these networks. In addition to the direct prohibition, there is a strong economic incentive provided by the local resale and unbundling requirements. These requirements force RHCs to sell their plant, piecemeal, to competitive carriers at below retail prices. This implicitly lowers the expected return on investment that RHCs can garner and, hence, reduces their incentives to invest in local broadband access networks. Other local exchange carriers that are not under these rules and restrictions have a dual interest in building backbone networks and hubs: providing backbone services and ensuring that their local broadband service customers can get guaranteed broadband speeds to the Internet backbone. In addition to the outright prohibition on the construction of interLATA transport and hubs, the interLATA restriction may have a chilling effect on local broadband deployment and investment.[6]

[4] *See e.g.,* Darby, Larry. *Innovation, Investment and the Role of Regulation*, Economic Strategy Institute, April 1998.
[5] Small, rural independent carriers are explicitly exempt under Section 251(f) of the Act.
[6] This hypothesis will be tested in another paper.

We therefore hypothesize that the regulations chill investment in the Internet backbone market and, specifically, investment in Internet backbone hubs. This can be measured by comparing the number of backbone hubs in areas served by independent LECs, which are unregulated, with the number of backbone hubs in areas served by RBOCs, which are regulated. Our hypothesis suggests that areas served by a larger proportion of independent LECs will also be served by more backbone hubs.

Model Specification

The model uses the ordinary least squares regression method (OLS) to estimate the impacts of three independent variables – income per capita, number of cities with more than 100,000 inhabitants, and percent of local access lines controlled by independent LECs on the dependent variable, number of backbone hubs in a state.[7] The following estimation model is used:

$$\gamma = a + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4$$

Where;

- γ = number of backbone hubs per state
- β_1 = income per capita, per state
- β_2 = number of cities with more than 100,000 inhabitants, per state
- β_3 = the percent of local access lines controlled by independent LECs, per state
- β_4 = number of CLEC resold lines, per state

The data set is comprised of various data from various sources as described below.

<u>Personal Income Per Capita in Current Dollars, by State: 1996</u> can be found in Table No. 48 of the Bureau of the Census, *Statistical Abstract of the United States 1998.*

> The personal income per capita variable is the most commonly used statistic to measure individual purchasing power. All other choices are problematic. Using an aggregate figure such as state gross domestic product (GDP) does not account for a state's population. One would not expect a state with a high GDP and a large population to be more attractive to backbone service providers than a state with slightly lower GDP but a much smaller population, ceteris paribus. Other figures that measure income per capita by household skew a reading on the number of people in a state.

<u>Cities with 100,000 or More Inhabitants in 1996 – Population</u> can be found in Table No. 727 of the Bureau of the Census, *Statistical Abstract of the United States 1998.*

> This variable is an excellent measure of the degree to which people live in clusters – an important motivator for backbone hub investment. In order to maximize revenue from a backbone hub, companies look for concentrations that can be served by a single hub. The more people, the greater the revenue stream to cover a hub's expenses. However, the presence of more people

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[7] The number of backbone hubs in a state is an important variable to study and to understand. Regulators should also be interested in measuring another variable: total backbone capacity available to communities. Like number of backbone hubs, total backbone capacity is an important measure of the ability of people to utilize broadband applications and to participate in ecommerce. Thus, a capacity measure would more precisely delineate the effects described in the model. Unfortunately, such a measure was not available. Both variables taken alone have their limitations: tremendous backbone capacity centered in a single city means nothing for rural communities elsewhere. Regarding number of backbone hubs, assume there are two states each with only one backbone hub. If one hub has ten times the capacity of the hub in the other state, clearly people will have very different on-line experiences, ceteris paribus.

alone is not sufficient as a predictor. A state with five large far-flung cities would exhibit more backbone hubs than a similar state with five large cities in close proximity.

This measure also reveals the "rural-ness" of a state. A greater number of cities with more than 100,000 inhabitants indicates a more urban state. We tested the validity of this statement by running the model with many other figures to estimate "rural-ness," including metropolitan and non-metropolitan populations, only non-metropolitan populations, percent of non-metropolitan inhabitants, and percent metropolitan inhabitants – all U.S. Bureau of Census data. None of the figures proved to be statistically significant and each skewed other estimators.

Why? These variables measure the size of urban and rural populations, but not the *concentration* of a state's population. Hence, a state like Virginia with large urban centers and large rural populations was no different to the model than Utah, despite the obvious differences influencing backbone hub investment. The unsuccessful addition and substitution of these other variables proves the common sense belief that companies build to places where people are clustered. (See appendix for more detail.) The variable, cities with 100,000 or more inhabitants, is the best measure to represent these differences.

<u>Number of Backbone Hubs in Each State</u> (Spring 1999) was obtained from Boardwatch, the leading source of information on Internet network proliferation.

<u>Number of Independent LEC Access Lines, Dec. 31, 1996</u> can be found in the Federal Communications Commission's *Statistics of Common Carriers, 1996.*

<u>Number of CLEC Resold Lines, per state, December 1998</u> can be found in the Federal Communications Commission report, *Local Competition*, Industry Analysis division, Common Carrier Bureau

The number of CLEC resold lines is a proxy for overall CLEC competition. It measures the number of access lines purchased and sold by CLECs to customers. It represents CLEC market share via resale. This variable is more robust and significant than other proxies for competition. The FCC keeps records of UNE loop purchases by CLECs, but this proved to not only be insignificant but also highly correlated with other variables in the model. The same was true for a composite variable created by adding CLEC resold lines and CLEC UNE loop purchases. Both of these variables and their impact on the model are explained later.

Information for each variable was collected for 46 states. Four states (Alaska, Hawaii, Connecticut, and Nevada) and the District of Columbia were excluded from the study for reasons specific to the unique nature of each state's infrastructure, regulatory and geographic considerations.

- Backbone builders treat Alaska and Hawaii, due to their remoteness to the rest of the nation, separately and distinctly.
- Connecticut is unique because an integrated carrier (SNET) offers local and long distance services throughout the entire state and its proximity to New York City, a major backbone hub center.
- The vastness and remoteness of Nevada, with three large population centers dispersed throughout the state, makes it unique even among western states.
- The District of Columbia, a single city, skewed the model, as it interfered with the estimation of number of cities, and because of its proximity to Northern Virginia, a major backbone hub center.

Results of the OLS Model

The model proves that all three factors are positive determinants of the number of backbone Internet hubs in each state. As expected, the model proved the following relationships:

- Higher income per capita is associated with more backbone hubs.
- Higher number of cities with 100,000 inhabitants is associated with more Internet hubs.
- Higher concentration of independent LEC access lines is associated with more Internet hubs.

The model was unable to determine a relationship between level of competition in the local access market (measured by CLEC resold lines) and Internet backbone hubs. Greater competition in local telephone service simply is not associated with more Internet backbone hub deployment.

The first three variables are significant at the 95 percent confidence level. This means that we can be 95 percent confident that income, city clusters, and regulation influence the building of backbone hubs in a state. The r-squared value is a robust 91.3 percent, indicating that the model is explaining 91.3 percent of the variation in the number of backbone hubs, per state.

Diagnostics showed that the model has no statistical problems.[8] The chart below reviews the statistical results of the model.

Variables t-Statistics in Parentheses)	**Model 1**	**Result**	**Implication**
Constant	-34.229 (3.335)	Significant	
Percent of ILEC access lines	27.923 (2.027)	Significant	LECs who are not under interLATA regulations incite the construction of more backbone hubs. A state with a higher percentage of lines controlled by unregulated independent LECs tends to have a greater number of backbone hubs.
# Cities >100,000	3.323 (17.427)	Significant	Backbone builders look to construct hubs in areas with large populations for revenue maximization purposes.
Income per cap	0.002 (3.855)	Significant	Higher income is associated with more Internet backbone hubs. There may very well be a symbiotic relationship at work, meaning that greater Internet hubs helps propel income which in turn propel more Internet hub deployment.
Percent CLEC Resold Lines	-50.285 (0.576)	INSIGNIFICANT	We can not say that a relationship exists between the proxy variable for competition and backbone hub deployment.
R-Squared	0.913	Very Good	The model explains 91.3 percent of the variation in number of backbone hubs by state.
F Statistic	109.	Very Good	

[8] The F value of 109.793 suggests that the model is, indeed, statistically significant in explaining some of the variation in the number of backbone hubs. The Durbin Watson test produces a value of 1.890, dismissing potential multicollinaearity/autocorrelation problems. No Pearson Coefficient exceeded 0.4.

The model indicates that an increase of $1,000 of per capita income in a state, all else being equal, would result in the construction of two additional backbone hubs, ceteris paribus. An increase of one city of more than 100,000 people would yield 3.32 additional backbone hubs, ceteris paribus. The model also shows that a ten-percent increase in the proportion of local access lines controlled by non-RBOC incumbents would result in an additional 2.79 Internet hubs, ceteris paribus.

The statistically significant coefficient on the number of ILEC access lines variable shows that states with higher concentrations of services by independent LECs have a statistically significant differ number of backbone hubs. This difference is unaccounted for by the two important economic variables – income and geographical differences. The model proves that some other factor is influencing backbone hub investment. The independent LEC access line variable captures the influence of regulation on backbone hub deployment. The model results suggest that if companies were not under these restrictions, more backbone hubs would be constructed. The model does not specifically say whether these Internet hubs would be constructed in different cities than those currently served by backbone hubs. But it does prove that there is a linear relationship between non-regulated control of access lines and backbone hubs across all states with various incomes. Hence, if the percentage of non-regulated access lines were increased, backbone hubs would be built in states currently without any backbone hubs. Therefore, we can deduce that some states and communities currently not served with backbone hubs would be served if a greater percentage of access lines were in the hands of non-regulated companies.

The number of CLEC resold lines is statistically insignificant, meaning that the model could not disprove the theory that there is no relationship between CLEC access lines and Internet backbone hub deployment. It is impossible to conclude that local competition has any relationship to the building of Internet backbone hubs. There are a few reasons for the lack of relationship. While local telephone competition is spurring deployment of voice-grade services, it has yet to make a measurable impact on the data/Internet market. This suggests that the market for voice and data services is still distinct. Additionally, while competition for high-end data customers is fierce in high-volume, high-margin markets, it has not reached the rural or small business markets. This competition is for services other than traditional telephone service, e.g., T1, frame relay, and the like, and hence has little to do with the service of local voice competition or the provisions of the Act meant to encourage such competition.

Conclusions and Policy Implications

The model confirms much that was already known. Companies build backbone hubs in places where their costs are lowest and potential revenues are highest. This maximizes their expected return on investment and fulfills their fiduciary responsibility to investors. States with more population clusters and higher per-capita incomes are served by more backbone hubs than states without those characteristics. More importantly, if a state increases its per-capita income or increases the number of population clusters, we would expect a linear growth in the number of backbone hubs as companies rushed in to serve these more profitable areas.

It is very difficult to alter the per-capita income or number of cities within states through specific policy measures. However, it is easier to change the regulation that impacts a state's backbone hub investment. States where a higher percentage of the population is served by non-regulated independent LECs have more backbone hubs. Over time, if that percentage were increased our model suggests that the number of backbone hubs in a state would increase.

For example, Oregon is a state with a per-capita income of $21,644 and with three cities containing more than 100,000 inhabitants. At the end of 1996, it had 25.3 percent of its local access lines in the hands of non-RBOC incumbent carriers, which are unfettered by the backbone restrictive regulation. The model predicts that this state should have 21 backbones, precisely the number of backbones as of spring 1999. It also implies that if Oregon were to increase the proportion of lines that were unregulated by 10 percent, it would add almost three backbone hubs. *If all lines in the state were under non-RBOC regulation, we would confidently expect Oregon to be served with 20 new backbone hubs.*

The model also identifies twelve states – we have termed them the "Disconnected Dozen" – which have significantly fewer hubs than most other states on a per-capita basis and are at serious risk of falling behind in the digital economy. Without an increase in hub deployment, these high-risk states stand to suffer significant economic consequences. Our model shows that regulations have seriously impeded the deployment of hubs in these states. If there were no regulations on the transfer of data, we would expect that each of these states would have substantially more backbone hubs today (see chart).

The Disconnected Dozen

States at Highest Risk

State	Actual number of hubs	Number of hubs if all lines were unregulated
Alabama	6	40
Arkansas	2	28
Idaho	2	30
Iowa	3	33
Maine	0	29
Montana	0	26
New Hampshire	3	42
North Dakota	0	24
Oklahoma	7	33
South Dakota	0	30
West Virginia	0	24
Wyoming	1	30

This paper demonstrates that a powerful tool for spurring investment and economic growth rests in the hands of policymakers. What this study shows is that deregulatory action will directly result in a substantial increase in new backbone hub deployment in all states. The new investment spurred by deregulation would have a profound impact on rural and urban broadband service. Such new investment would provide many rural communities with the first real broadband option – permitting real-time applications and other broadband services. Rural ISPs currently crossing interLATA boundaries to get to Internet backbone hubs could see the cost of linking to the Internet backbone fall by as much as $500,000 per year. This is an enormous cost reduction, particularly for a provider serving a small community. For urban broadband users, this investment would provide greater choice and lower price to ISPs in others. Many of these new hubs will complement existing hubs and provide not only competition, but the redundancies necessary to ensure the high quality of service that ecommerce, ebusiness, and consumers demand. Reducing investment-constraining regulations on LECs will substantially reduce the cost of service, improve the level of service, and increase the availability of services and applications throughout the country.

Questions about the Model

As with any statistical model, there are different hypotheses that can and should be tested. There are also always questions regarding additional considerations that should be asked. This section attempts to anticipate and address such questions.

Is it possible that the regulatory variable is accounting for competition and that it is actually competition – and only competition – that is driving greater backbone hub deployment across the country?

No. We attempted to measure competition through a number of proxy variables cited by the FCC to show the development of competition. None of these variables showed a statistically significant relationship with the dependent variable. The following table shows the various model specifications run to show conclusively that there is no relationship between any measure of local telephone competition and Internet backbone hub deployment per state.

Figure 1

Variables (t-Statistics in Parentheses)	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Constant	-34.229 (3.335)	-35.463 (-3.562)	-34.672 (-3.641)	-34.302 (-3.295)	-34.929 (-3.624)	-34.501 (-3.746)
Percent Other Lines of Total	27.923 (2.027)	26.627 (1.975)		28.104 (1.998)		
# Cities >100,000	3.323 (17.427)	3.308 (17.657)	3.432 (18.548)	3.321 (17.101)	3.428 (18.178)	3.351 (17.341)
Income per cap	0.002 (3.855)	0.0018 (3.964)	0.002 (4.441)	0.002 (3.766)	0.002 (4.389)	0.002 (4.335)
Percent CLEC Resold Lines	-50.285 (-0.576)		-10.58 (-0.12)			
Percent CLEC Resold Lines + Percent UNEs				-38.919 (-0.442)	-1.787 (-0.02)	
Percent UNEs						1071.227 (1.109)
R-Squared	0.913	.908	0.904	0.914	0.904	0.907
Durbin Watson	1.890	1.795	1.63	1.824	1.58	1.701
F Statistic	109.793	148.647	138.599	106.844	135.241	139.521

Model 1 is the final model specification used in this paper. Model 2 shows the model without the competition proxy variable. The model is unbiased and efficient, and all the variables, including the regulatory proxy, are significant. In Model 3, we substitute the regulatory proxy for the competition proxy, CLEC resold lines. The result shows that the competition proxy is insignificant and the explanatory power of the model decreases. More troubling, the model shows autocorrelation via the low

Durbin Watson figure, signifying that the model's estimates are unbiased, but inefficient. For similar reasons, it is necessary to reject Models 5 and 6 as inefficient. Model 4 keeps the regulatory proxy and includes a new composite proxy for competition – a combination of CLEC resale lines and CLEC UNE lines. This model performs about as well as the first model, although the first model shows a more robust Durbin Watson and F Statistic.

The above model tested each variable reported by the FCC to measure the level of local telephony competition by state. None were statistically significant, meaning that local telephony competition can not be shown to have a statistical relationship with the number of backbone hubs in a state.

Does the relationship predicted by the model only work for urbanized states or for states with high incomes?

The relationship described by this model is linear. This implies that states with fewer cities benefit just as much as states with more cities from having more lines under non-RBOC regulation. The same holds true for levels of per-capita income. Again, this specification was found to be the most statistically valid and to have the greatest explanatory power of all the competing models that were tested.

While there is bound to be some statistical variation, most states conform quite well to the model's predicted relationship, as seen in the appendix. It can also be expected that most states would react similarly to changes in the number of lines with non-RBOC regulation.

Are there other model specifications that work better to explain "clustering"?

The model specification works well because it flows from common sense. The model proves superior both logically and statistically to other possible specifications. The linear relationship that this model assumes provides a much stronger explanation for the data than does a logarithmic model (which has a much lower R-squared term, and in which all of the T values decrease and one variable becomes insignificant) or a squared relationship.

Furthermore, other models with different variable combinations were tested to show the relative strength of this model. None could match its high degree of explanatory power or the statistical significance of its variables. The model is a better, more valid predictor than specifications using different combinations of population density, urban and rural populations, total number of independent LEC lines and number of cities with high Web-use ratings. Finally, the inclusion of the variable "percent of non-RBOC lines" is validated by the statistical improvement it brings to the specification.

Figure 2

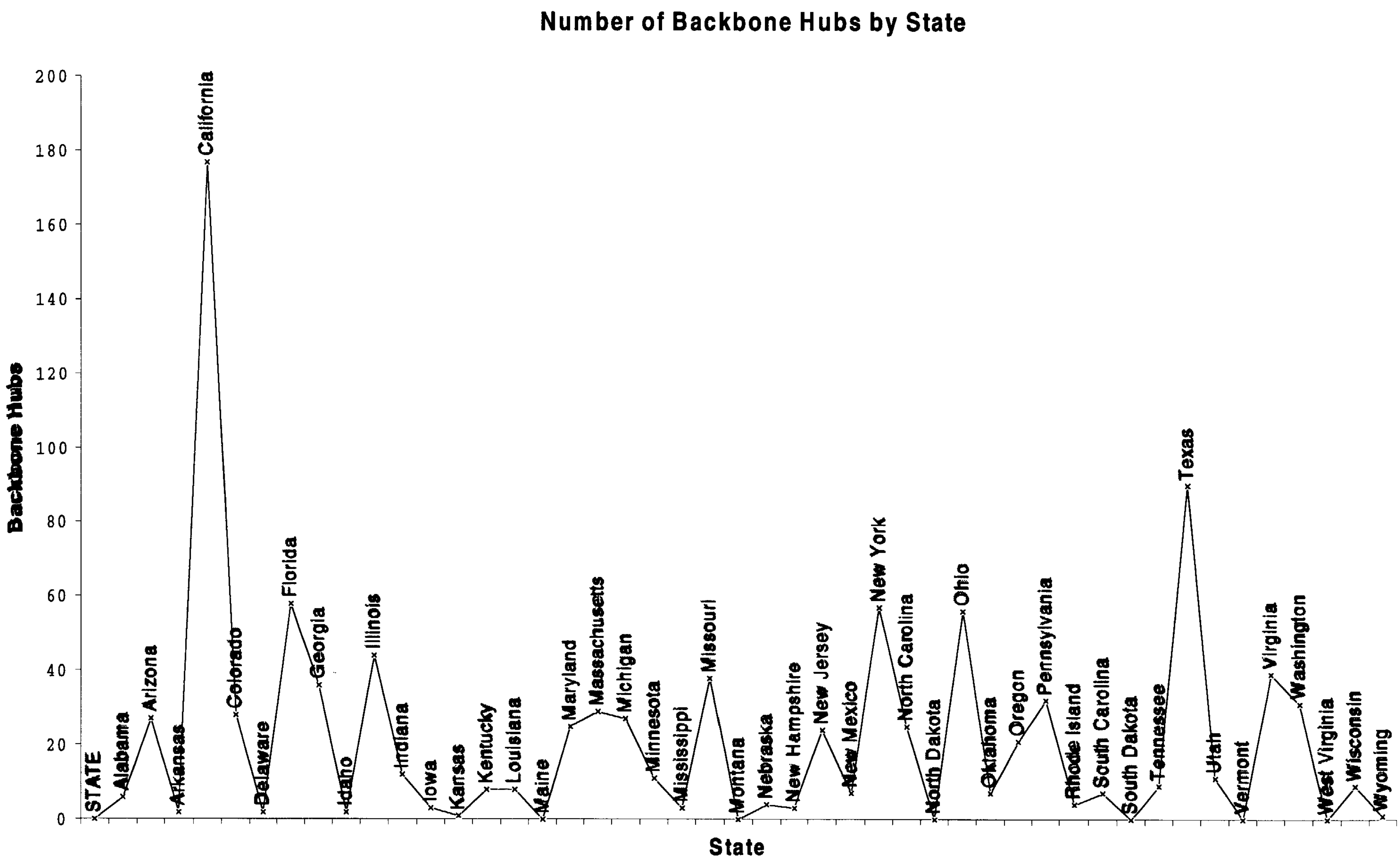
Variables (t-Statistics in Parentheses)	Model 1	Model 2	Model 3
Constant	-35.463 (-3.562)	8.310 (0.774)	-77444 (-2.150)
Percent Other Lines of Total	26.627 (1.975)	4.489 (0.319)	100.397 (2.695)
Income per cap	0.002 (3.964)	-0.001 (-0.982)	0.004 (2.369)
# Cities >100,000	3.308 (17.657)	3.308 (17.657)	3.432 (18.548)
Metropolitan Population		0.005 (17.478)	
Population per Square Mile			-0.015 (-0.613)
R-Squared	0.914	0.912	0.281
F Statistic	109.793	148.647	5.483

An example of the testing of other possible models is given in Figure 2 model.[9] It is evident that among these choices, Model 1 is the best of three alternatives that attempt to account for the urbanization of a state.

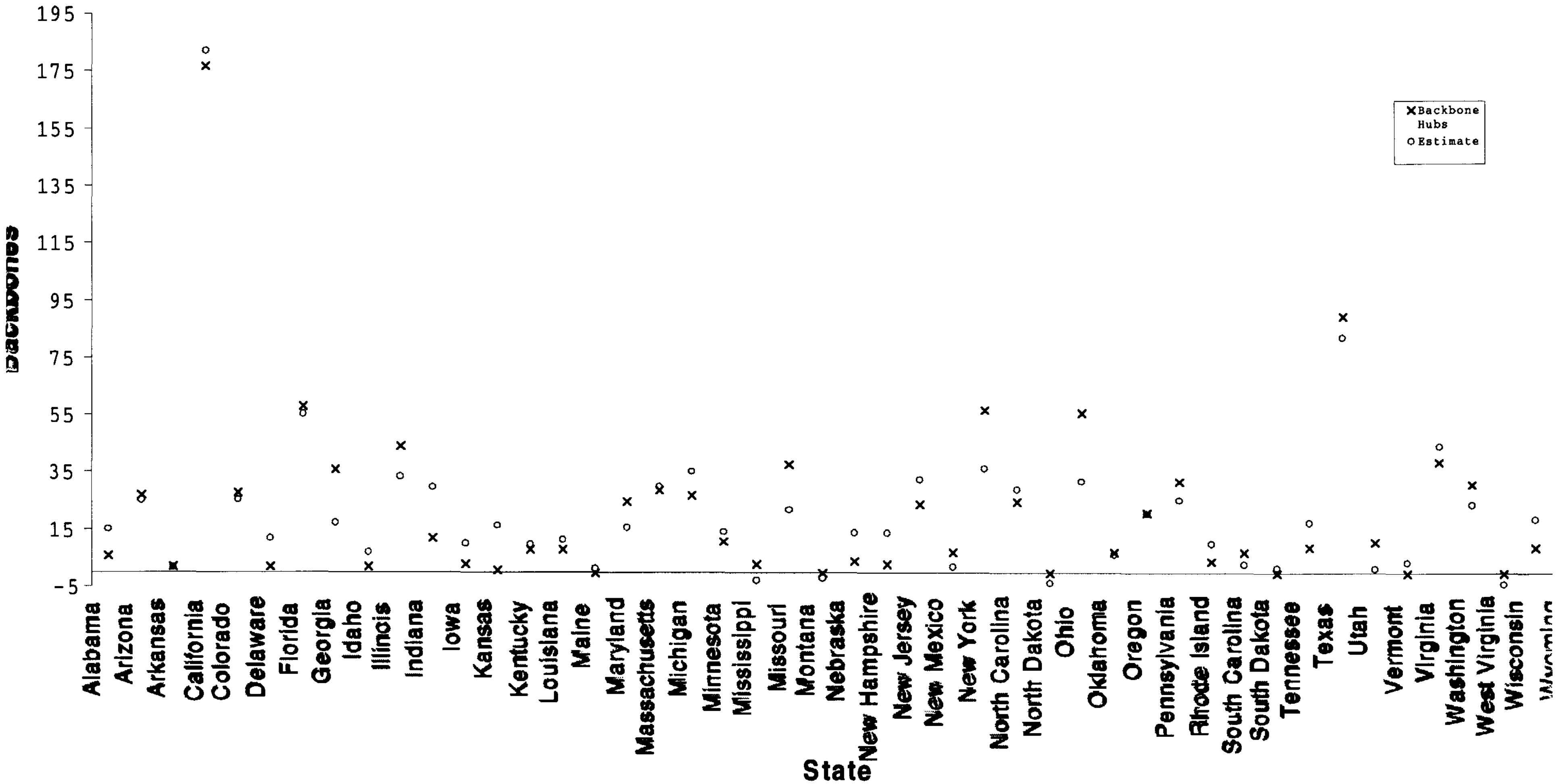
Model 2 has similar R-squared and F-statistic measures, but cannot produce statistically significant coefficients. Metropolitan population is a worse predictor of number of backbone hubs than Number of Cities because it does not distinguish between States with one highly populous city (which could be served by fewer backbone hubs with higher capacity, potentially) and several smaller cities. Furthermore, the coefficients for the other two variables no longer conform to rational relationships, partly because metropolitan population captures more of the effect of income per capita than number of cities does, and "takes credit" for the effect of the income variable. The metropolitan population variable is twice as correlated with income per capita, as is the number of cities variable.

Model 3 is far worse. It has extremely low predictive power and statistical significance as a model, with an R-squared and F-Statistic of 0.281 and 5.483, respectively. Population per square mile does not account for population clusters, which is the important predictor for backbones (as shown in Model 1). Without this vital element, the relationships between the other two variables and backbones are represented at a greatly elevated level to compensate. The model as a whole does not account for the data correctly.

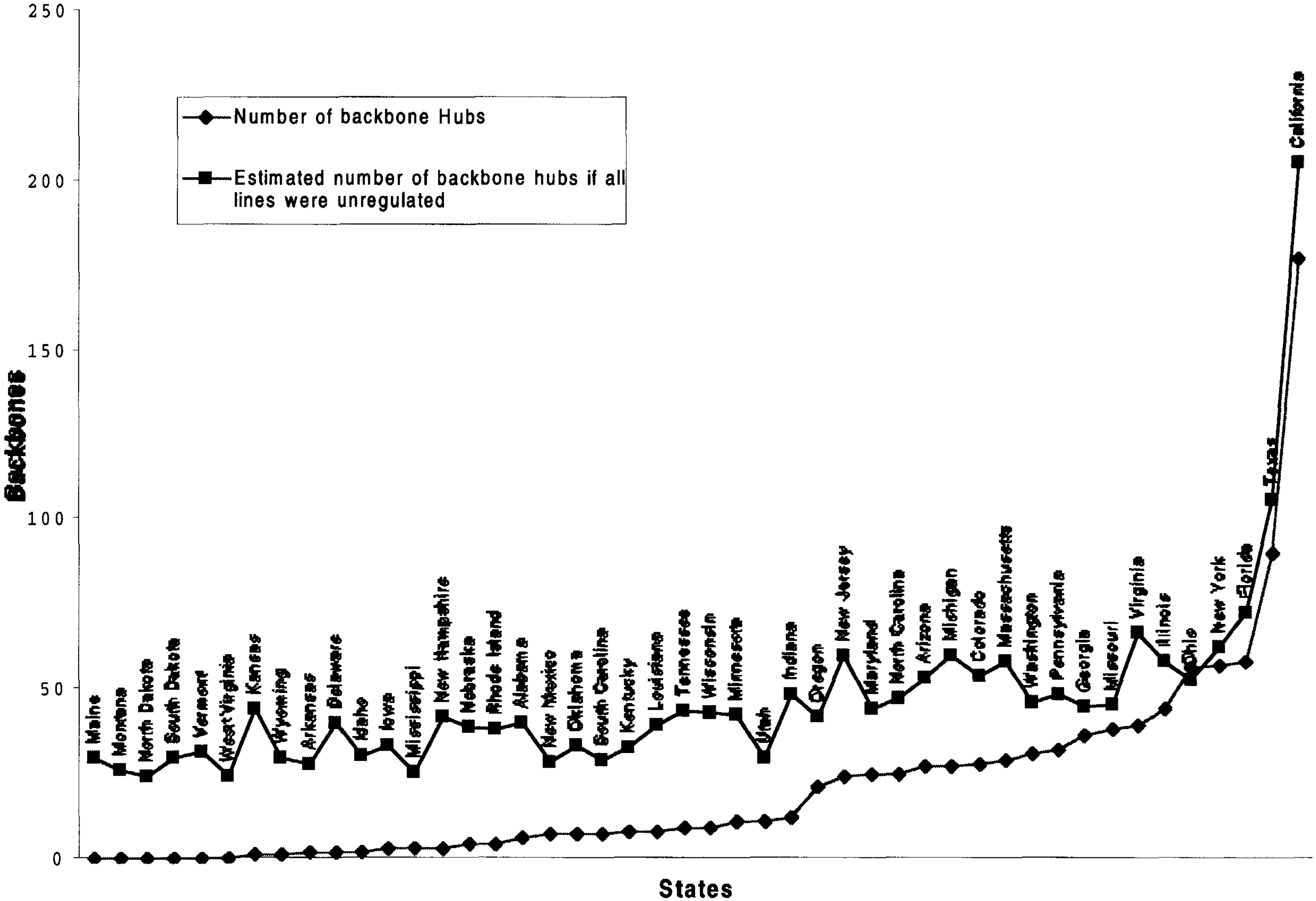
[9] These model specifications were performed prior to the insertion of a competition proxy. Because of the fundamental and gross problems that arose in the models when alternative clustering variables were substituted, there was no need to rerun the model with a competition proxy.


Number of Backbone Hubs by State
Backbone Hubs
0
20
40
60
80
100
120
140
160
180
200
State
STATE
Alabama
Arizona
Arkansas
California
Colorado
Delaware
Florida
Georgia
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

Number of Backbone Hubs by State and Model s Estimations



Comparison of Current Number of Backbone Hubs and Estimated Nu
All Lines Were Unregulated



STATE	Number of backbone Hubs	Estimated number of backbone hubs if all lines were unregulated	Total increase if all lines were unregulated
Maine	0	29	**+29**
Montana	0	26	**+26**
North Dakota	0	24	**+24**
South Dakota	0	30	**+30**
Vermont	0	32	**+32**
West Virginia	0	24	**+24**
Kansas	1	44	**+43**
Wyoming	1	30	**+29**
Arkansas	2	28	**+26**
Delaware	2	40	**+38**
Idaho	2	30	**+28**
Iowa	3	33	**+30**
Mississippi	3	26	**+23**
New Hampshire	3	42	**+39**
Nebraska	4	39	**+35**
Rhode Island	4	38	**+34**
Alabama	6	40	**+34**
New Mexico	7	29	**+22**
Oklahoma	7	33	**+26**
South Carolina	7	29	**+22**
Kentucky	8	33	**+25**
Louisiana	8	39	**+31**
Tennessee	9	44	**+35**
Wisconsin	9	43	**+34**
Minnesota	11	42	**+31**
Utah	11	30	**+19**
Indiana	12	48	**+36**
Oregon	21	42	**+21**

STATE	Number of backbone Hubs	Estimated number of backbone hubs if all lines were unregulated	Total increase if all lines were unregulated
New Jersey	24	60	**+36**
Maryland	25	44	**+19**
North Carolina	25	47	**+22**
Arizona	27	53	**+26**
Michigan	27	60	**+33**
Colorado	28	54	**+26**
Massachusetts	29	58	**+29**
Washington	31	46	**+15**
Pennsylvania	32	49	**+17**
Georgia	36	45	**+9**
Missouri	38	45	**+7**
Virginia	39	66	**+27**
Illinois	44	58	**+14**
Ohio	56	52	**-4**
New York	57	62	**+5**
Florida	58	72	**+14**
Texas	90	106	**+16**
California	177	205	**+28**
Average	**21**	**47**	**+25**
TOTALS	**984**	**2149**	**118%**

Examples of the Effects on Three States of Changes in Regulated Lines

State	Income per capita	Number of Cities >100,000	Percent CLEC Resold Lines	Percent of Lines with Non-RBOC Regulation	Number of Backbone Hubs	Increase over Current Figures
Oregon						
Current	21,644	3	3%	25.3%	21	
Increase of 10 percentage points	21,644	3	3%	35.3%	23.79	2.79
No Regulation	21,644	3	3%	100.0%	41.56	20.56
Massachusetts						
Current	27,972	4	0%	0.0%	29	
Increase of 10 percentage points	27,972	4	0%	10.0%	31.79	2.79
No Regulation	27,972	4	0%	100.0%	57.92	28.92
Kentucky						
Current	18,329	2	2%	18.8%	8	
Increase of 10 percentage points	18,329	2	2%	28.8%	10.79	2.79
No Regulation	18,329	2	2%	100.0%	32.71	24.71